A Look At How Yield Builds Over Time

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For 1996 we predict an above average dry bean yield for Scotts Bluff County of 2178 lbs/ac. In September of 1995 we predicted the Scotts Bluff County dry bean yield at 1731 lbs/ac. Nine months later in June 1996 the Nebraska Statistical Reporting Service released county average yield for Scotts Bluff at 1789 lbs/ac. These values are within 3 percent of each other. Read on for insights into the factors that determined yields in 1995 and 1996.

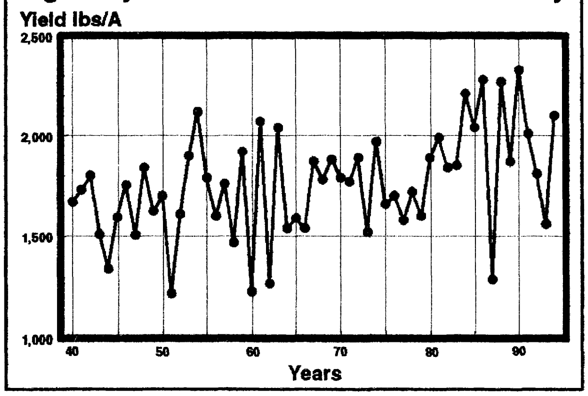
Being able to predict yield is significant but not as important as naming the factors that determine yield and understanding how yield builds over time. Once yield influencing factors are named our chances of managing them greatly improved.

Average years don't happen! Yearly yield variability for Scotts Bluff County from 1940 to 1994 is shown in Figure 1. Yield averaged 1728 lbs/ac over this period with a range of 1110 lbs/ac from a low of 1250 lbs/ac in 1951 to a high of 2360 lbs/ac in 1990.

Eleven factors were selected to explain variability of past yields and also predict current year yield. Five of these factors describe disaster events and technological progress. The six remaining relate weather parameters to the phenological development of the bean plant.

Disaster events were defined as disruption in water distribution system, pervasive hail, and early fall frost. Water disruption occurred one in 50 years with the last being 1973. Pervasive hail has occurred one in ten years. An early fall frost occurred 14 percent of the time.

Fig 1. Dry Bean Yields for Scotts Bluff County



Yield gain from technological progress has been slow, averaging only 3.7 lbs/ac/year. In 1984 a one time yield jump of 144 lbs/ac occurred when new disease tolerant high yielding public and private Great Northern varieties were introduced. The most significant variety was Beryl.

With disaster events and the contribution of technological progress quantified lets concentrate on weather and its effects on yield. Weather data (temperature maximum and minimum and precipitation amount and occurrence) were taken from the Mitchell 5E weather observation station. Five phenological time periods of 21 days each were established and for 1995 and 1996 are shown in Figures 2 and 3. Phenological development within each 21-day period was expressed in growing degree days (GDD) base 50.

Fig 2. 1995 Daily Weather by Growth Period

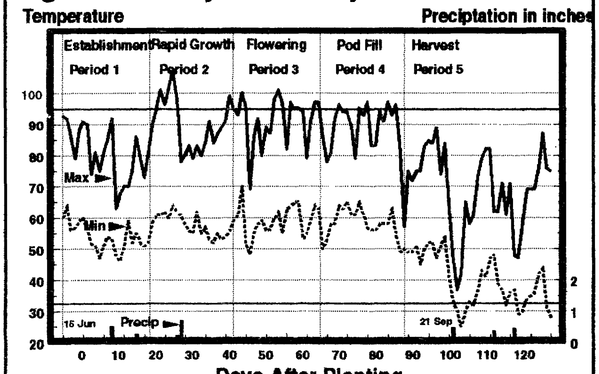
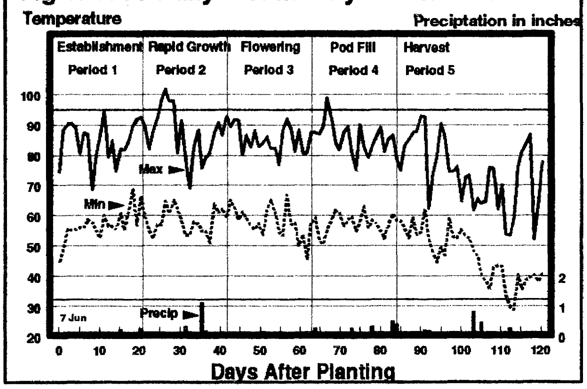


Fig 3. 1996 Daily Weather by Growth Periods

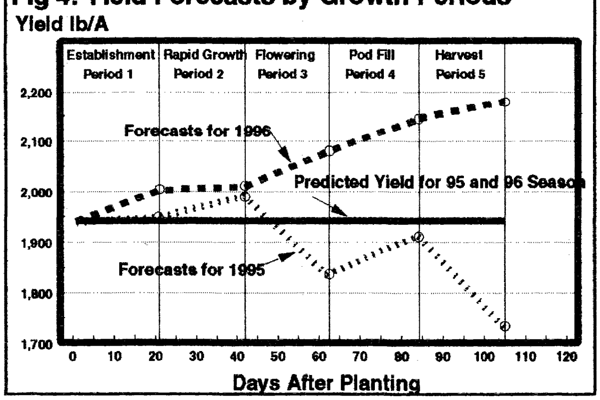


Two factors expressing phenological stress were number of days the maximum temperature was 95 degrees or above during flowering in period 3 and the white mold effect (1963-1994). White mold was first diagnosed in Scotts Bluff County in 1962 and has been a significant yield robber in years where the disease is favored by strong early season vine growth coupled with numerous rain events in the last half of the growing season. The white mold variable is an interaction between GDD for period 2 and total number of rain events during periods 3 and 4.

When disaster events occur, we find that: disruption in the water delivery system dried up yields by 314 lbs/ac, a pervasive hail slashed yield by 340 lbs/ac, and an early fall frost cuts yield by 250 lbs/ac. Technological progress at 3.7 lbs/ac/year is a painfully slow area to look for increases in yield with the exception of the 1984 varietal driven shift. Also every day the maximum temperature is 95 or greater during flowering yield diminishes by 26 lbs/ac. In 1995 we had ten such days. It would take seven years of technological progress to equal one day of yield loss due to high temperature during flowering development.

Let's follow the process as it works through the growth periods for 1995 in Figure 4. For the first and second periods all values are held as historic average except GDD which were above the average values by 9 and 39 units respectively. This resulted in favorable temperature for plant growth prior to flowering and a forecasted yield, 42 days after planting, of 1991 lbs/ac.

Fig 4. Yield Forecasts by Growth Periods



During period 3 the maximum temperature was 95 or above ten times reducing yield forecasts by 260 lbs/ac. One hundred and five lbs of this reduction was offset by favorable GDD resulting in a forecasted yield of 1836 lbs/ac 63 days after planting.

At the end of period 4, there had been no pervasive hail and white mold did not factor in because of absence of rain events during periods 3 and 4 and again temperature for plant development was favorable which brought forecasted yields up to 1913 lbs/ac 84 days after planting. Then came the destructive 21 Sept frost during period 5 which drove the forecasted yield down to 1731 lbs/ac.

In 1995 favorable GDD values in the first four growth periods and freedom from pervasive hail and white mold contributed positively to yield. Temperature of 95 or above during flowering and early frost depressed yield 206 lbs/ac lower than the predicted yield line of 1937 lbs/ac in figure 4.

Compare the weather data for 1996 in figure 3 with that of 1995 in figure 2. Maximum temperature in 1996 was not as high and there were no days of 95 or above during period 3. The result was that yield built positively over the first four periods as shown in figure 4. Also, contributing to positive yield is the low number of rain events in periods 3 and 4 which held white mold in check. Although hail was present in varying areas, it was not pervasive over the entire county. In addition we escaped an early frost in period 5.

Nineteen ninety six was a season of favorable temperature for growth with no production disasters or phenological stressors. This results in a forecasted yield for the season of 2178 lbs/ac. If this forecast holds it will be the fifth highest yield reported for Scotts Bluff County ever.

IF, in 1995, the early freeze and the 10 days the temperature was 95 or above had not happened the yield <u>could have been</u> 2240 lbs/ac. The point here is that both 1995 and 1996 had the basic ingredients for above average yields. One disaster event and one phenological stressor depressed 1995 yield 509 lbs/ac below what it <u>could have been</u>. What can be done? A place to start is to select varieties for reasonable maturity to avoid early frosts. Varieties are not evaluated for flower retention at high temperatures. Should they be? Considering Scotts Bluff County alone 260 lbs/ac yield loss in 1995 * 40,000 ac * value of $.20/lb is a good answer.

The seasonal yield of dry beans is influenced by many factors. A study of historic yield makes possible the forecast of future yields by phenological periods and leads to an understanding of areas of yield vulnerability.

It is in this way that we develop a future history that is useful in understanding and managing variability in dry bean yields that we have experience for the past five and a half decades.